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## ANALYSIS OF LEARNING PROCESSES AND SPECIFIC TEACHING<sup>1</sup>

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There was once a boy who was shown by standard tests in arithmetic to be deficient in subtraction. A further fact was that he was shown by the same tests to be unusually strong in multiplication. This boy illustrates in a very impressive way a fact of the broadest and most general significance. We shall not concern ourselves for the moment with his private difficulty in subtraction; we are interested in his case as revealing the contribution which tests can make to classroom work and also as showing the limitations of tests. This boy's progress in arithmetic was undoubtedly affected adversely by his lack of mastery of subtraction, and the tests did him and his teacher a great service in making clear the exact point at which his deficiency was to be found. The limitations of the test appear in the fact that it does not tell the teacher what to do with the case. If the teacher is to cope successfully with this boy's educational needs, there must be something more than the test. There must be an explanation reaching back into the boy's method of subtraction which will show why he was weak in this particular. There must be an analysis of the case more fundamental than that which the test makes. The test was only a first step.

In the particular instance under consideration the analysis was performed by Professor Uhl, who reported the case. It was found that when this boy was asked to subtract 9 from 46, he turned the problem into one which could be solved by the use of his highly perfected multiplication table. Starting with the 46 which was given, he set aside 1 so as to secure a number that should be an exact multiple of 9. He then disintegrated his 45 into five 9's and

<sup>1</sup> Paper read at the general meeting of the Department of Superintendence of the National Education Association, March 2, 1921.

dropped one of the 9's, thus performing the subtraction called for. After getting rid of his 9 by this roundabout method he restored the 1 originally set aside and thus arrived at the final result.

The analysis of this boy's method of subtraction explains at once why he was slow. The complex series of steps which he took explains why he often fell into error in subtraction. The analysis also reveals why he was able to pass the multiplication test with a high score. Finally, the analysis shows the teacher exactly where instruction must be applied if the boy is to be helped to improve and also what instruction must aim to do.

This paper is a plea for such analysis. Much of our teaching in the past has been less successful than it should be, not because teachers have lacked in industry or devotion to their work, but because they have not been able to apply their efforts specifically and directly to the center of the pupil's problem.

Suppose, for example, that the teacher in the case cited had blamed the boy for his slow subtractions and had disciplined him as a wanton failure; would good have come from the punishment? When a child is operating with wrong intellectual methods he does not know it. In the intellectual world in which he lives, the method that he uses is the accepted method because it is the only known method. To say to a child that he is wrong does not help him. The teacher is in the classroom and in the study-room for the specific purpose of analyzing pupils' efforts and discovering where difficulties arise.

Analysis which shall lead to specific teaching is the new movement in the science of education which naturally follows the testing movement and supplements it. We are at the opening of a new era in the scientific study of educational problems. The testing movement has for the last decade been in process of establishing itself. Most of us can remember the skepticism with which the early tests were received. There was an intense emotional recoil against the showings of those early tests which had to be outlived. It is little wonder that school administrators and students of education have been absorbed for years in the working out of tests and other devices of measurement. Time and effort were required to perfect and introduce them.

Today the testing movement may be said to be fully accepted. No one seriously questions the possibility or desirability of measuring school results. Yet, at the moment of the most complete success of the testing movement there seems to be a lack of enthusiasm which is so baffling in its significance that some observers have thought of it as a symptom of decline.

Everybody gives tests in all the fundamental subjects, but many people regard the resulting scores as quite useless for practical purposes. What does one do about the matter when he finds a school or an individual pupil below standard? In a great many cases surveyors of schools have reported tables of figures showing that this or that is not well done and have then left town apparently deaf to the question: What is to be done to improve the situation?

I say again that it is easy to understand why the science of education had to spend much time and effort in measuring results. Indeed, today, as formerly, the best way to bring a school system to its feet is to test results. But we are mature enough in the application of scientific methods of education to enter upon a second era, the era of constructive, positive correction of defects. This will be the era of analysis and of specific teaching. No more are we to be content merely to measure results; we shall try to understand results and consciously produce a new kind of result by dealing with causes.

Another example which will illustrate what I am saying can be drawn from a field in which testing has been until very lately altogether infrequent, namely, from the high school. A few months ago President Brown of the Oshkosh, Wisconsin, Normal School published a monograph giving the results of extensive tests which he had made in the Latin classes of New Hampshire when he was connected with the department of public education of that state. President Brown's tables require careful study and yield certain results which he himself has not noted. The particular fact which we may select for our present purpose is the striking fact that pupils gain practically nothing in the power to read Latin during the third year of their study. The results of second-year Latin are meager, but the results of the third year are zero.

I imagine that there will be a great deal of hysterical repudiation of these findings by many Latin teachers. It is always thus when unpleasant revelations are made. Human nature strikes out blindly in self-defense whenever it is attacked. In due time, however, we may look for a saner reaction. The facts which are plain enough will be faced. Third-year Latin is a conspicuous failure. This is the showing of the tests and the unquestionable fact. When the fact is thus accepted, Latin teachers will begin to ask a new and really significant question, namely, the question: What is the reason for the failure of third-year Latin?

When this rational question emerges there will be ushered in a new era of Latin teaching and a new attitude of analysis of Latin problems. There will begin a movement which will carry progress beyond the tests farther than tests have carried us beyond the original state of mere complacency with conventional teaching.

Let us try a hand at the kind of analysis which should follow the Latin tests. The third-year pupil fails to make progress because he has very bad habits of dealing with the Latin text. He picks out his translation word by word. He spends most of his time with his finger in the vocabulary hunting up a possible meaning to fit into the puzzle which he calls an English sentence. This set of habits is what the pupil acquired during the first and second years of his study. We may be willing to defend the vocabulary habit in the early stages. Perhaps it is a legitimate first method, just as creeping is a legitimate first method of personal locomotion at a time when one commands no better. But there comes a time when creeping must be superseded by something more expeditious and effective. So it is with Latin. There comes a time when, if the study of this subject is to be of value, it must carry the pupil over a sentence at a time, rather than a word at a time. There comes a period in the pupil's development when reading ought to mean in Latin what it means when the learner is able to get from a page of the vernacular real ideas and coherent thoughts. The vocabulary method of translation bars the pupil from this kind of free, intelligent reading. The vocabulary method when carried up into the higher levels of the course is as abnormal and as backward as would be the imbecile creeping of a full-grown man.

If the analysis suggested is in any degree correct, it opens the way for a series of experiments by Latin teachers which will be sure to be productive. The cycle of evolution will then be as follows: first, the test to show the present condition; second, intensive analysis to explain the result; third, experimentation to improve the situation; fourth, more tests; fifth, more analysis; and so on.

In one sense there is nothing new about all this. Teachers of every generation have done something of the sort. For that matter, there is nothing new about any of our modern science. Men have always observed nature and have always followed their observations with new efforts to adapt their behavior more intelligently to what they have seen. Yet we know there is in modern science something essentially new. To the earlier, cruder observations of primitive man have been added devices and equipment for more exact observation. Analyses have been made more intensive and far-reaching, and adaptation has become more energetic and specific.

What modern science has meant in other spheres, educational science should mean for our school work. Teachers of experience have always improved their teaching by analyzing situations and by changing their methods in the light of their analyses. Educational science is a refinement of what good teachers have always done. The testing movement was the first stage of this science and made possible an exact evaluation of the results at which we have arrived by our present methods. The testing movement was a decided refinement of earlier methods. The analyses which I am advocating as guides to specific effective teaching are refinements of what was done earlier in some degree by good teachers, but done all too little.

Furthermore, the science of education will have to improve along another line which has characterized the progress of modern science in other fields. Science has added to human equipment for co-operation in analysis and experimentation. No physicist or astronomer works today in isolation. The group co-operates in the development of what we call objective analyses and objective results.

So must it be in the science of education. Many an excellent teacher has carried to his grave insights which would have been of immense value to his fellow-teachers. The loss of these insights is due to the fact that in education we have developed only limited means for making wise analyses the common property of all. We are just beginning in education to learn how to pool our experiences. I believe the decade that has passed, with its intense discussions, has been nothing but the training school for a mature science in which observation will become as common and as objective as in any sphere of investigation.

It is my profound faith in co-operative analysis of school situations which gives me courage to believe that the student of educational science in his laboratory and the classroom teacher may both contribute to the development of better teaching. I look forward to the time when our educational literature will include in large measure statements by teachers of cases with which they have been able to deal. There ought to be a great many reports like the one which I quoted of the boy whose subtraction had gone wrong. There ought to be a great many experiments on how to follow the vocabulary habit in Latin with something more productive. When we have many such reports the spirit of analysis among our teachers will be fostered, and there will be a great deal more of what I have called specific teaching.

There will also be a greater taste for the kind of material that my colleagues of the educational laboratory produce. Of course, I am selfishly interested in getting a wider attention for laboratory work, not because it seems to me different in spirit from what good teachers do, but because I believe that the best teaching requires analyses which can be made only with the aid of laboratory methods.

An analogy may help me to make clear what I mean. There will never be a time in medicine when the practicing physician in direct contact with the patient will not be necessary. But there is a growing recognition on the part of the doctor of medicine of the importance of the laboratory man who stands back of him. The modern doctor is constantly using the laboratory analysis to check and help his practice. This is what I am advocating in education as an aid to better teaching.

Let us take a concrete example. My colleagues and I use in our study of reading elaborate apparatus which photographs the eyes of readers. The ordinary teacher used to think of such apparatus as very remote from her classroom work. I remember when Huey published his book in 1909 a great many teachers said that it was not practical and doubted whether the reading of the book was worth their while. But the work which was just beginning in 1909 has been slowly carried on by others. Laboratory analysis is a slow, laborious task, requiring more time and equipment than most people realize. The result of twelve years of work has, however, justified all that has been expended on research.

I wonder how many of you realize the extent to which our schools are today engaged in a fundamental reform as a result of the scientific studies of reading. The distinction between oral and silent reading is a direct product of these investigations. Huey pointed out in a general way the importance of the distinction twelve years ago. It remained for the later, more complete investigations of my colleagues to establish the distinction and make it useful to teachers.

The importance of clear insight into the distinction between oral reading and silent reading can hardly be exaggerated. The whole fabric of school life is made up of reading. In general, primary teachers begin well in the teaching of reading. The middle grades and upper grades have in the past failed dismally to do their parts effectively. Upper-grade oral reading is quite as stagnant as third-year Latin, and for reasons not unlike those which we reviewed in the earlier case. Oral reading in the upper grades is a slow, clumsy form of reading, tending to impede the pupil's intellectual progress. Oral reading is a perfectly legitimate form of reading in the primary grades. It is the natural and proper introduction to reading. The analogy of creeping to be followed by walking is altogether legitimate and instructive here. The child must first read by relating printed words to his oral speech. He ought later to read without oral speech.

All this is perfectly clear when one has the laboratory material on reading in hand. Photographs of the eye-movements of readers show that immature reading involves looking at each word as a



unit. The eyes pause on each word long enough to make recognition possible and to allow for the slow reaction of pronunciation. The reading of a mature reader is of an entirely different type. The eye now takes in, not the single word, but a whole phrase; and its movements are more rapid because there is no delay in waiting for pronunciation.

As soon as we understand the character of silent reading and oral reading, we are able to organize our classroom work on a sound scientific basis. At the present time we are in the beginnings of this organization. Enough analysis of these two kinds of reading has been made to send the word abroad among educational people that they will have to make over the school program in reading. Enough interest has been aroused to make this one of the richest and most influential fields of inquiry.

There are two reasons why such inquiry is delayed. I shall comment on these two reasons because I believe that the possibility of improving teaching through the application of the science of education depends on our ability to find some method of setting aside the obstructions.

The first reason why the distinction between oral and silent reading has been only moderately useful to teachers is that the distinction has not been clearly understood. As a result, instead of being thought of as a detailed description of a difference between two stages of development, it has been treated as a kind of partisan issue. It has been scoffed at by some and overworked by others. There is a great deal of personal prejudice in our profession. Some teachers say the whole thing is a myth. They like oral reading; they know how to teach it, or think they do, and they are going to retain it. Put in terms of our present discussion, such teachers have never appreciated the value and helpfulness of analysis. They prefer to teach in a general way rather than to give well-directed, specific instruction.

At the opposite extreme are some people who, having heard that the distinction between oral reading and silent reading exists, forthwith desire to throw away for all time the old. Let the first grade have only silent reading, they say. They argue from the fact that adults read silently and gain advantage therefrom to

the conclusion that silent reading should be cultivated from the first, that oral reading is a pernicious and useless invention of a bygone age. Such extreme reformers herald their doctrine in the most unqualified and absolute terms.

Both of the groups whom we have described, the scoffers and the exclusive silent readers, are wrong. They delay the analysis which will set the whole matter right by their violent partisan attitudes. They have not caught the spirit of true scientific procedure.

The second reason why the inquiry into the distinction between oral reading and silent reading progresses slowly is one that I wish I had the power to set forth so clearly that we might instantly overcome it by going to our respective places and energetically introducing a much-needed reform. The school system of the United States is absorbed in routine. We give little or no energy to analysis of what we are doing. The time was when the factory also was absorbed in the routine of making things. But the factory has long since learned that it can well afford to invest in thinking about its work. The best factories have laboratories to which problems of manufacture may be referred. These laboratories are not charity institutions; they are not things apart. They are centers of life in the establishment.

I am frank to say that I grow discouraged at times with some of the school situations in this country where administrators and teachers are unwilling to spend the time necessary to consider their fundamental problems. I grow discouraged when I find that the work done in our reading laboratory, for example, reaches only a comparatively few people. I grow discouraged when I encounter people who think of a scientific laboratory as an institution located in the clouds, if not in a fog. We are a generation of busy, rushing routinists. We plunge into the day's task and are industrious enough to satisfy our various consciences, but we are not willing to absorb ourselves in careful analysis. Too often we are not willing to absorb ourselves even in the study of analyses made by others.

For my part, I shall go on advocating analysis of school situations as the most important need of the times. I shall say what I

can to encourage the experienced teacher or administrator to stop for a time for the study and comprehension of what is going on. I shall say to young men and women who are inexperienced but are looking forward to a career of teaching: Take time now in your preparation to look into school situations and see what they involve. I shall try to pick out the most promising candidates and encourage them to carry on the long, arduous studies which in the long run will redound, as does all truly scientific thinking, to the advantage of all.

Especially shall I seize every opportunity which presents itself to ask administrative officers to see the importance of analyzing the situations with which they deal. I often come in contact with people who want to be given the results of scientific studies without giving themselves the pains to make any contribution. The fact is that the only way one can understand scientific analyses is to make some one's self. Every physician is a scientist and is successful in so far, and only in so far, as he analyzes his patients. Every judge or lawyer who serves the community in the highest degree must understand the fundamentals of jurisprudence and must be a keen analyst. So it is also in our profession. There is no room in the higher positions for a mere routinist. Analysis and re-analysis are the price of the highest success.

If each of us in his own way would adopt some method of promoting analysis, there is no reason why the new era of analysis and specific teaching should not come in with a rush. Let the school administrator encourage his teachers to study intensively a few cases each year and record the results. Let the superintendent show the principal that it is his chief duty to throw light on school problems by making an intensive analysis of them. Let boards of education be brought to understand the importance of investing public funds in such analyses, even to the extent of supporting laboratory work. Let the teacher who shows skill and insight in such work be assigned to tasks which will most productively utilize his or her ability.

This, then, is my urgent plea for a new movement in the science of education as the best and most promising method of securing better teaching.